

# SpreeLand: An Expert Avatar Solution for Virtual World E-Learning Environments

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**Abstract—** Virtual Worlds offer new opportunities for e-learning solutions. To exploit these opportunities e-learning solutions need to utilize the virtual worlds' rich collaboration environment to offer enhanced and integrated real learning services combined with virtual e-learning services. However, there are many challenges to achieve these goals, such as finding experts that can interactively answer a given query, and matching the virtual and real identity of that given experts. In this paper, we study these issues and propose a framework for virtual e-learning solutions to integrate an expert avatar service to Virtual World e-learning environments to enrich those environments with one of the most important real learning futures, which is the ability to ask experts and get instant feedback. In our proposed solution, we implemented a web services based expert finding system for 3D virtual worlds to automatically identify the most qualified resident (expert avatar) to answer a given query. The nature of the proposed system as Web services architecture will increase scalability by allowing other virtual worlds to integrate with. Virtual e-learning environments will have great interest in the proposed solution, since it will on one hand improve the interactivity of users and on the other hand open opportunities to facilitate exchange of information between e-learning users.

**Index Terms—** Virtual World, Expert Avatar, E-Learning.

## I. INTRODUCTION

Usage of 3D Virtual Worlds as e-learning environments reached a large extent in the last decade. Thus, Virtual Worlds became a significant research field with a focus on how can Virtual Worlds offer new opportunities for learning. A study on educational developments in 3D Virtual Worlds showed that 75% of UK universities are active in 3D Virtual Worlds [1]. 3D Virtual Worlds as e-learning environment achieved user satisfaction worldwide in different academic disciplines [2]. Thus, e-learning solutions need to exploit the rich collaboration environment of Virtual Worlds to offer enhanced and integrated real learning services with virtual e-learning services. To investigate the capabilities of virtual e-learning environment Media Richness theory have been applied. Media Richness Theory classifies the communication media in order of decreasing richness to; a) face-to-face, b) video, c) voice, d) written, addressed documents, e) documents f) unaddressed documents. Face-to-face communication is considered the richest medium because it provides instant feedback and multiple cues via body language, tone of voice, smell, visual look, temperature and other physical real world cues. Researchers in [3] have

arguably included Virtual Worlds by ranking it below a but above b. This is because Virtual Worlds lacks real life cues such as instant feedback from real world, but since it support real time video it includes all video capabilities in addition to other virtual world features. Instant feed back from real world in virtual e-learning environments can be achieved by integrating real learning services with virtual e-learning services. One of these "real learning services" is finding experts that can interactively answer a given query. Therefore, matching the virtual and real identity of that expert person will enhance instant feed back in virtual e-learning environments. Our objective in this paper is to study these issues and propose a framework for virtual e-learning environments to integrate an expert avatar service to e-learning environments in order to enrich e-learning environments with one of the most important real learning futures, which is the ability to ask experts and get answers. Furthermore, evaluating the proposed framework in terms of Media Richness Theory from Management Information Systems point of view, to investigate the richness achieved by instant feed back enhancement.

Our proposed expert finding system mainly targeted at virtual e-learning environments, in which interaction between education process components (student, instructor, and course material) is often a significant problem: students need to be able to find experts easily, and without too many steps. In the proposed solution, we implemented an expert finding system for 3D virtual worlds based on Web Services. It automatically identifies the most qualified resident (expert avatar) to answer a given query. The system provides an add-on service to Virtual Worlds e-learning environments, which enables active users to search for experts that may not be represented currently in the virtual world to communicate and interact with regarding a certain e-learning content. Our work is based on a prototype that integrates the widely used virtual worlds in e-learning with the "Spree" Expert Finding System implemented in our Lab [8]. It provides an online tool, to enables individuals within a potentially large e-learning environment to search for experts in a certain area. Our prototype integrates the open source virtual world Wonderland from Sun Microsystems [9] as one of the widely used virtual worlds in e-learning with our "Spree" Expert Finding System [8]. The nature of the proposed Web services-oriented architecture will increase scalability by allowing other virtual worlds to integrate with.

Section 2 presents theoretical background about virtual worlds. Afterwards, Spree, as classification and matching engine, Wonderland as e-learning environment, and Web Services as standard technology to handle application logics over HTTP are presented. In section 3 we show the system architecture and implementation of: SpreeLand. Section 4 outlines the evaluation principles used to judge the system. Section 5 specifies the drawbacks and future works. The last section concludes our work.

## II. THEORETICAL BACKGROUND

Digital ecosystems comprise 2D interfaces through Web 2.0 applications, as well as 3D interface through virtual worlds are changing how humans interact online [4-5]. Indeed 3D Virtual Worlds offer rich potential which is still being explored and developed [6]. 3D Virtual Worlds have been described as “online environments that have game-like immersion and social media functionality without game-like goals or rules. At the heart is a sense of presence with others at the same time and in the same place [7]. These qualities of immersion and presence are facilitated with the presence of an avatar.

Spree is a web-browser based application, mainly targeted at larger corporations, in which discovery and dissemination of available information is often a significant problem [8]. In spite of that World Wide Web offers many possibilities to get questions answered such as: Bulletin and question boards, Search engines, Messengers, Network and contact management portals and Email. To differentiate Spree from the previously mentioned systems, we can say that its approach tries to solve some knowledge management problem areas [8] as in the following: The main functionality of the Spree system is to facilitate access to existing knowledge. This is achieved through means of an expert. Therefore, a large population of experts has to be actively participating in the Spree community. Spree tries to facilitate the conservation and archival of existing knowledge by making it easy for experts to create offline “notebook entries” from online chats they had with questioners. In Spree users can edit their notebook entries in order to make them more readable or to improve matching. Questioners can rank experts and notebook entries according to their perceived usefulness. To facilitate exchange of ideas, generate new ideas and train users, Spree uses synchronous ways of communication between users, i.e. chat, whenever possible.

Wonderland developed by Sun Microsystems is a pure Java and open source toolkit for creating collaborative 3D Virtual Worlds. Within those worlds, users can communicate with high-fidelity, immersive audio, share live desktop applications and documents and conduct real business [9]. The vision for this multi-user virtual environment is to provide an environment that is robust enough in terms of security, scalability, reliability, and functionality in order for organizations to rely on it as a place to conduct real business. The types of collaborations that can happen within the space

include audio communication, live desktop applications of all kinds, and eventually collaborative creation of world content both graphical and procedural [10].

Availability of Internet access and standardization of Web technologies have lead to an explosion in the use of Web Services technology to handle business applications over standard internet protocols, typically using HTTP with an XML serialization. Consequently, the Web Services have become a platform for applications to share business logics.

## III. SYSTEM ARCHITECTURE

The architecture of our system (SpreeLand), integrates Wonderland Virtual Worlds with Spree using Web Services technology. SpreeLand functionality implemented on a central server as a pool of Web Services, client module built on top of Wonderland client to interact with the pool of Web Services via HTTP protocol, the corresponding Web Service communicates with the Spree classification and matching engine to handle the functionality of expert finding as illustrated in Figure 1.

### A. Wonderland Client-Server Architecture

The client to server communication architecture of Wonderland Virtual Worlds is designed in three main layers as Figure 1 shows. The lowest layer is the protocol layer, which is used by all clients to select how they communicate with the server. Above the protocol layer is the session layer, which organizes Java-based clients into an extensible set of connections. Finally, the connection layer is used by the application to send application-specific data. This design allows building extensible communications architecture to reflect the persistence of one client to other clients in high performance [11].

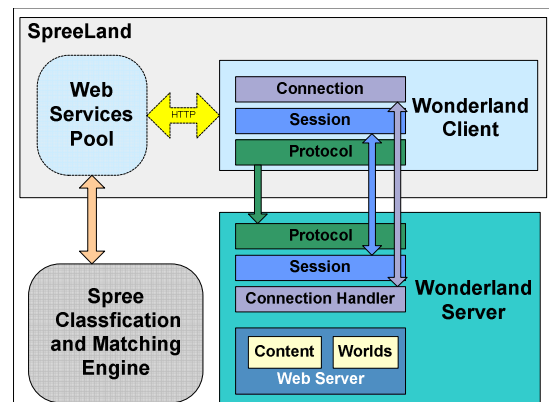


Figure 1. Communication architecture of SpreeLand system

Wonderland has client-server architecture. In this architecture every user interacts with the system in the same way. If anything changes, everyone should be kept updated. Users should be able to connect at any time and see the current state of the world. Users do not need to know anything about the physical location of any other user in the

real world. In server side Virtual Worlds is stored on a computer at a particular IP address. The server knows everything about the virtual world; it stores all the objects that will be displayed, controls how different parts of the Wonderland system communicate with each other, and knows which users are inside the virtual world. The client is on another computer, at a different IP address. The client must log into the server to join a virtual world. After the client logs on, the server sends a copy of the Virtual Worlds to the client. Lots of different clients can be logged in, each running on a different computer. All this communication is handled by Wonderland. But we must write code to plug our own Wonderland module that communicates with Web Services Pool to extend Wonderland client functionality based on the Wonderland communication system mentioned earlier.

### B. Wonderland Module Architecture

The Wonderland module architecture is simply a set of Java classes and other resources packaged up into a jar file and published into the Wonderland server. Modules facilitate adding extra functionality without having to recompile and redistribute the entire system [12]. Wonderland module consists of virtual entities (cells), every object displayed in the virtual world is represented by a cell object. Each client has its own copy of the cell object that handles the behavioral law of the virtual entity, behavioral law used to specify the actions performed by the virtual entity [13]. When the client makes a change to an object, this changes the cell object's data. This change must be sent to the server, which must then update all other clients. The server contains a managed object for each cell to handle the reaction law, reaction law specifies how the virtual world changes according to all the simultaneous actions of the virtual entities. Managed objects are used to maintain synchronization of the cells between different clients. Figure 2 illustrates the relationship between Wonderland server and module client objects.

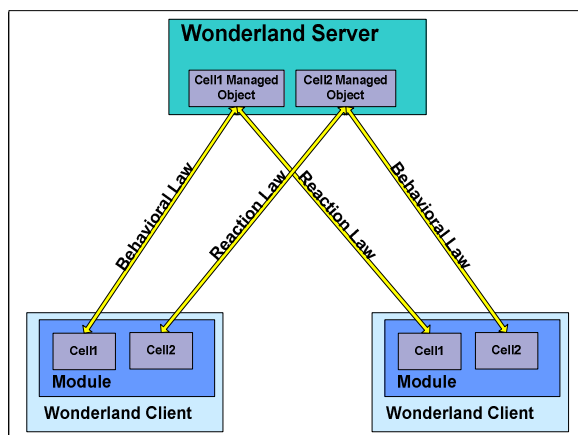


Figure 2. Synchronization mechanism of Cell object used in Wonderland

### C. SpreeLand Architecture

The implementation of client module in SpreeLand follows the basic Wonderland client to server communication system. SpreeLand functionality is implemented on Web Services Pool and we utilize the Wonderland client module as the Web services client application, benefiting from its capability to communicate over standard internet protocols such as HTTP. We rely on the recent Java Monkey Engine (JME) used in the last release of Wonderland 0.5 to develop a rich GUI in the 3D space for enhanced usability. Furthermore, we use Java Swing to provide standard GUI elements as shown in Figure 3. SpreeLand client used to submit query in the form of natural language question. SpreeLand client will send the question to the corresponding Web Services for classification and matching.

The specified Web Service communicates with the Spree classifying and matching engine to classify questions basing on ontology, and returns a list of classification key words. if the user is satisfied with these classification key world, he/she can ask the system to find experts, then system sends request to the corresponding Web Service that consults Spree that returns a list of experts. This list is displayed by the system and the status of the experts is shown to the user as shown in Figure 4.



Figure 3. Screenshot of SpreeLand client to handle a query

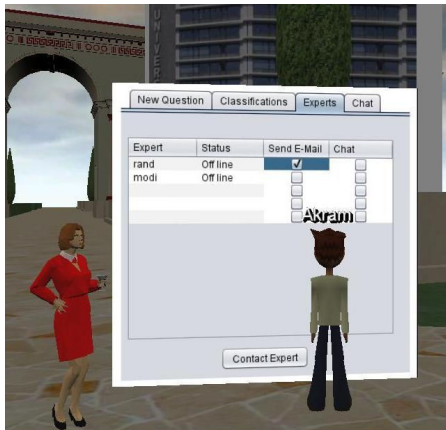


Figure 4. Screenshot of SpreeLand experts display and select GUI

The communication session is started by the system and the user can interact with the selected expert based on his status and user selection, on line expert can be contacted by e-mail or through online chat session, while the off line experts can be contacted by e-mail only. Another important feature of the SpreeLand system is its reliability. To ensure a high quality of service to the users we are investigating caching and polling solutions, which decrease the load on the server. Once the user send request for classification, server side will try to find the matched experts and cache them in advance, when the user get satisfied with the suggested classification and decide to get the matched experts, they will be available through the serialized XML in HTTP session. In server side Web Services will keep track of the current request status to reduce redundant processes by matching the status of the request with cached status in the corresponding Web Service as shown in Figure 5.

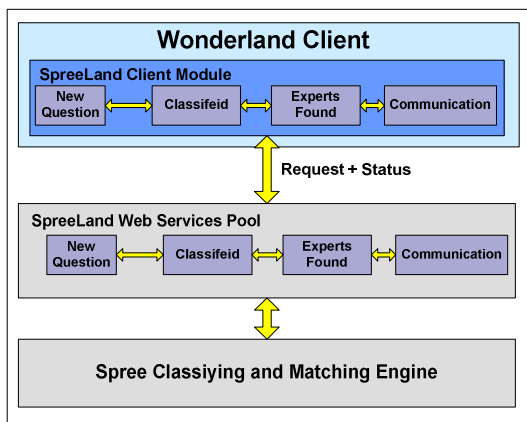


Figure 5. Request status matching mechanism between client and server in SpreeLand

#### D. Spree classifying and matching engine Architecture

In the Backend, Spree classifying and matching engine incorporates topic specific ontology, which allow for mapping queries and expert profiles into abstract semantic spaces [8]. The Spree system is based on the use of an ontology tree where each node corresponds to a (sub-) topic or area of knowledge. Consequently, the fields of expertise (profile) of the participating experts can be thought of as sub trees of this ontology. Since user queries, too, can be mapped to sub trees, assigning queries to relevant experts becomes a graph matching problem. In an offline preparation step, Spree associates each node of the tree with a corresponding bag of words harvested from related Internet resources. Since expert profiles provided by means of resumes, web pages, notebook entries, as well as user queries can be turned into bags of words, too, they can be matched against the nodes of the ontology [8]. Here, matching can be computed efficiently, and results obtained from experimental evaluations demonstrate the viability of the approach.

Additionally, Spree server-side framework integrates a standard database (MySQL), a web server (Apache), and the Spree matching engine server also facilitates real-time communication between users via instant messaging (chat). Since the Spree client-side is fully implemented within the Web browser all client-to-client communications have to pass through the server. This feature has been utilized by SpreeLand to facilitate the communication interoperability of Wonderland Virtual Worlds client to Spree client, where SpreeLand client's instant messages sent via Web Service to Spree chat server.

Another important feature of the SpreeLand system is its scalability. The system is Web services-oriented, and can be easily integrated with other systems by implementing the Web Services client proxy to interact with the other Web services.

#### IV. SYSTEM EVALUATION

By evaluating the SpreeLand framework in terms of Media Richness Theory we investigate the richness achieved by interactive feedback. Integrating SpreeLand service to e-learning work flow enriches e-learning environments with one of the most important real learning futures, which is the ability to ask experts and get answers. Therefore, matching the virtual and real identity of that expert person will increase instant feedback richness in virtual e-learning environments. We investigate if the system fulfills the criteria of effectiveness and satisfaction according to [3].

To indicate the goodness of the integration between activity needs and virtual world capabilities for instant feedback factor specified in [3], we used Activity-Capability Indicator (ACI) which is a number between 0 and 1 computed by weighting a Need Indicator (NI) and a Capability Indicator (CI) to each other. NI indicates how important the factor is for the educational activity. E.g. the need for instant



feedback in a negotiation role play such as e-learning process is high and set to 0.9. Likewise CI indicates the capability of the virtual world to support a factor. E.g. the capability of typical Virtual Worlds to provide instant feedback is medium high as justified below therefore CI is set to 0.6. This gives ACI equal to  $0.9 * 0.6 = 0.54$  [3]. An ACI equal or close to 1 signals a very good fit while a factor equal or close to 0 indicates a bad fit. SpreeLand framework enhanced the instant feedback of Virtual Worlds by at least 0.2 based on the assumptions used in [3] to weight instant feedback CI to 0.6. Thus, in our framework instant feedback will be weighted by 0.8, leading to ACI equal to  $0.9 * 0.8 = 0.72$ , which means about 33% Media Richness enhancement in instant feedback factor. SpreeLand pushes ACI close to 1 signal which means a very good fit in e-learning environments.

Spree has been tested by several testing methods, in order to investigate and to get indications on how Spree as web application usability and performance can be improved, the test users were members of DAI-Labor and Deutsche Telekom Laboratories [8]. Spree's Enhancements are reflected to SpreeLand, since the last relies on Spree as back end classifying and matching engine.

## V. DRAWBACKS AND FUTURE WORK

The proposed SpreeLand system provides valuable features for Virtual Worlds e-learning environments. However, much work remains to be made in the future to accommodate new technologies to improve expert finding mechanism in terms of quality of service, by updating ontology used by Spree classification engine with data retrieved from 3D Virtual Worlds. In addition, unifying chat service used in Wonderland with the one used in Spree classifying and matching engine will enhance system connectivity. While unifying user directory (LDAP) service used in Spree and Wonderland, by implementing viable centralized authentication service will lead to better integration. Finally, the proposed framework should be implemented in further virtual worlds such as Second Life to expand SpreeLand services to one of the most widely used virtual environments.

## VI. CONCLUSION

In this paper the SpreeLand system was developed and proposed as a framework for virtual e-learning solutions to integrate expert avatar service to e-learning work flow. SpreeLand allows enriching e-learning environments with the ability to ask experts and get answers as instant feedback. In our solution, we implemented a web services based expert finding system for 3D Virtual Worlds to automatically identify the most qualified expert avatar to answer a given query. SpreeLand integrates the Wonderland Virtual Worlds with the "Spree" Expert Finding System. The Web services

architecture of SpreeLand allows scalability and reliability enhancement. This architecture, integrates Wonderland Virtual Worlds with Spree using Web Services technology. SpreeLand functionality implemented on a central server as a pool of Web Services, GUI module built on top of wonderland client to interact with the pool of Web Services via HTTP protocol, leads to a communication with the Spree server to handle the functionality of expert finding.

The proposed system has been evaluated in terms of Media Richness Theory to indicate the grade of fitness between activity needs and virtual world capabilities for instant feedback factor, a bout 33% Media Richness enhancement in instant feedback factor was found, leading to a very good fit in e-learning environments.

E-learning environments will have great interest in the proposed solution as we expect, since it will on one hand improve the interactivity of users and integrated real learning services with virtual e-learning services, on the other hand it will open opportunities to facilitate exchange of information among e-learning users, such as finding expert person competent in interactively answering a given query and getting instant feedback.

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